JAERI Beamline II (BL14B1)

1. Introduction

BL14B1 is a JAERI Material Science I beamline for experiments in various kinds of structural studies, particularly in the field of high pressure/high temperature science and surface/interface structural studies. The construction of the beamline was completed in October 1997. It has been used for scientific programs since March 1998.

The light source of BL14B1 is a bending magnet. The basic concept of the optics is adopted in the SPring-8 standard bending magnet beamlines, for example BL01B1 and BL02B1. Therefore, the main optics contain a double crystal monochromator and two bent plane mirrors. One mirror is located upstream and the other downstream from the monochromator. The specifications of the optical elements are listed in Table 1.

The synchrotron radiation from a bending magnet has a continuous spectrum. It is a feature of BL14B1 that a monochromatic beam or white beam can be used according to the experimental purpose in high pressure/high temperature studies. Namely, the monochromator and mirrors can be removed from the direct beam to carry out experiments with the white X-ray beam. We have two experimental hutches at BL14B1, and experiments using the white beam are permitted only in the upstream experimental hutch, which we call the white beam hutch. It naturally has higher radiation-shielding ability than the downstream one, which we call the monochromatic beam hutch. Accordingly, there are three types of experiments at BL14B1:

i) White X-ray experiments in the white beam hutch.
ii) Monochromatic X-ray experiments in the white beam hutch.
iii) Monochromatic X-ray experiments in the monochromatic beam hutch.

2. Improvements of Monochromator

Immediately after starting beamline operation, fluctuation in the intensity of the monochromatic beam was observed. This phenomenon was also observed when the mirrors were removed, but not for the white beam. Therefore, it is likely that the vibration of a first monochromator crystal with a water cooling system caused the beam intensity fluctuation. In order to avoid crystal vibration, we performed the next improvements by working on a cooling water circulation system. The following summarizes these improvements.

i) To remove the pulsation from the water pump of the chiller, the attenuator was inserted on the cooling water path.
ii) A metallic flexible water tube was first used in the monochromator chamber. The unevenness of its interior can generate random flow in cooling water. We exchanged it for a synthetic flexible tube with a smooth surface.
iii) It was also necessary to optimize the flux of cooling water to decrease the amplitude of crystal vibration. We installed a bypath tube with an adjust bulb for the cooling water path. Consequently, adjusting the flow has become very easy.

After taking these measures, the beam intensity

Table 1. Optics of BL14B1

Horizontal Acceptance	1.5 mrad
Energy range	
for monochromatized beam	5.0~90 keV
for white beam	5.0~150 keV
Energy resolution	$\Delta E/E \sim 10^{-4}$
Monochromator	
type	Double crystal Si, saggital focusing
distance from source	36.8 m
First Mirror	
type	Collimating, Vertical Bent Plane, Rh on Si
distance from source	35.1 m
Second Mirror	
type	Collimating, Vertical Bent Plane, Rh on Fused Quartz
distance from source	40.2 m
Sample Position from source	
in the white hutch	46.0 m
in the monochromatic hutch	55.0 m

fluctuation decreased below 0.2 %.

3. Experimental Stations

We have installed two kinds of experimental station at BL14B1.

One is a new multi-anvil type high pressure apparatus system in the white beam hutch. The main part of its high pressure generation device is a DIA type multi-anvil apparatus placed on an 180 ton uniaxial hydraulic press. Six cubic anvils are mounted on the guide block, and these anvils compress a cubic-shaped pressure medium isotropically. Using this apparatus, high pressures and high temperatures up to 15 GPa and 1,500 K can be generated. In order to carry out an angle-dispersive powder diffraction experiment as well as an energy dispersive diffraction study, it can have two-dimensional detectors instead of a Ge SSD. Two concentric vertical goniometers are placed near the high pressure apparatus. An SSD for the energy dispersive diffraction is mounted on the outer goniometer. On the inner goniometer, a solar slit is mounted. This solar slit is used to reduce the background noise signals from the sample surrounding materials such as the pressure medium for the angle dispersive experiments using an imaging plate or a CCD detector. The center of the solar slit is also used as a single collimator in the energy dispersive experimental method. An X-ray absorption experiment under high pressure can also be carried out with a monochromatic beam.

The other experimental station is a new κ-type multi-axis diffractometer in the monochromatic hutch. This diffractometer is used for structural studies on liquid/solid interfaces, solid/solid interfaces, glass, single crystals and so on. It has four axes for orienting the sample (ϕ, κ, ω, φ), two axes for positioning the detector (θ, η), and toe axes for setting the analyzer crystal (ωa, θa). For surface and interface diffraction studies, this diffractometer is equipped with another axis (ν) for azimuthal rotation of the detector slit. This novel axis allows accurate measurement of the surface structure factor even in the case of large perpendicular momentum transfer.

Fig. 1. Multi-anvil type pressure apparatus system.

Fig. 2. κ–type multi-axis diffractometer.